The Healing Virtue of Light

The Medical Art of Chromotherapy

THE art of healing by colored light, to which the name chromotherapy was applied hardly more than twenty years ago, is discussed in *La Revue* by Dr. Laumonier. After a brief introduction of historical examples of such treatment empirically, especially in cases of measles, scarlet fever, and small-pox, he continues:

"The modern method of treatment by colored light is principally based on the studies of Engelmann and Winogradski. These authors, experimenting on unicellular organisms, vegetable and animal, such as algae, bacteria, antherozoids, protozoa, etc., have established that the manifestations of elementary life present their optimum normal activity between the orange and the green of the solar spectrum. If we project a small spectrum on a drop of water containing different microbes, we perceive, after a time, that the microbes have become assembled in the region of the orange-yellow, yellow, and yellowish-green rays. This is not merely the result of a mechanical attractive influence; vital reactions have been effectually increased, as shown by the abundance of gaseous disengagement and the greater rapidity of cellular bipartition.

"Two other phenomena are equally notable. On the one hand, in the red and infra-red, which represent the hottest and most penetrating part of the spectrum, the vital activity of the microbes is exaggerated, but soon ceases, as if exhausted by their very excess.

"On the other hand, in the blue-indigo, the violet and the ultra-violet, the part of the spectrum richest in chemical radiations, the vital activity progressively slackens and disappears, by the gradual destruction of the living matter, which degenerates.

"From the biologic point of view, therefore, there are three fundamental regions in the spectrum: the red, temporarily superexcitant, but finally exhausting; the yellow, and above all, the green, endowed with a lasting power of maintaining equilibrium; and, finally, the blue and the violet, sedatives at first, but subsequently inhibitors and destructive irritants.

"But if colored light produces such effects on isolated living cells, how does it act on the tissues of complex organisms, and, especially, on the nervous elements, the most sensitive of all?

"This question is answered by the numerous researches made by Young, Semper, Forel, and others on the larvæ of insects, tadpoles, etc., which all attest the influence exerted on nutrition and development by the different regions of the solar spectrum.

"Apart from phototherapy and heliotherapy, which utilize the total white light, solar or other, we find in the memoir of Dr. Bie, presented to the Congress of Wiesbaden in 1902, the first systematic essay on chromotherapy. Bie also found the red exciting, green stabilizing, and violet sedative. He proved, moreover, as indicated by Prof. Charles Boucard, that red light does not irritate the skin, but has a power of penetration much greater than the blue, which on the contrary, though

highly irritated, is superficial in action. Shortly afterward, Dreyer, of Copenhagen, sought to make use of these discoveries by injecting or painting the integuments with histochemical red solutions (trypan red, for example), to render them more permeable to the bactericidal action of blue or violet rays. We know, too, that many other colors, the methylene blue, methyl violet, eosin, etc., have been used against certain injections—ocular, gynecologic, cancerous, etc., but it is believed at present that the colloidal state of these colored substances has more influence than their coloration.

"Finsen, the great protagonist of phototherapy, utilized red light—like the Chinese—against small-pox, and blue light against eczema, lupus and certain malignant tumors of the skin. His success encouraged others to try his method, and thus Thymann, Bickerod, and Schoull used it against scarlet fever. Chopf, of the Nuremberg Children's Hospital, reported that under the influence of a sojourn in the 'red room,' the exanthema of the little invalids paled and disappeared, fever lessened and complications lost their gravity. But when the stay was not sufficiently prolonged the eruption and fever reappeared after the emergence from the room.

"Equally satisfying results were obtained by Bie in small-pox; by Krækenberg in erysipelas, it being sometimes sufficient merely to paint the pimples or blotches with red. But it is especially against measles that the treatment with red light (erythrotherapy) is recommended."

The author cites many physicians who support this practice, but confesses there are others who question its efficacy. Dr. Gougert made some interesting tests, whose results he reported in the *Prese Medicale* in 1909.

He installed a red room in the measles ward of the Claude-Bernard Hospital by pasting red paper on the window panes and putting red shades on the electric lights. Likewise the patients were clad in red garments. Of the 24 patients all over 15 years, there were none who died and only two whose cases were complicated by laryngitis. The initial conjunctivitis and the swelling of the face were favorably affected. The eruption was perhaps somewhat lessened, but the fever was not modified. Hence he gives qualified support to the treatment. The author finds Gougert too pessimistic and thinks the test not conclusive; first, because the epidemic was of a mild type; second, because the sojourn (averaging two days) was too short; and third, because the subjects were all adults, "less exposed to the gravity of the infection than children, and with integuments more resistant to the penetration of the red rays." He continues: "... The red rays are not bactericidal; they act through the nervous system on which they exert a dynamogenic action so strong that it may result in a veritable state of excitation. ... But this action and the reinforcement of the vital resistance consequent upon it are dependent on the penetration of the red rays. But this penetrability, itself conditioned by the structure of the

integuments, ... is considerably weakened in the adult, whose skin is thicker and harder. ...

"The blue and violet light operate differently. With less penetrating power it is ... energetically bactericidal and irritating to the skin. The violet and ultra-violet rays, especially from the mercury-vapor lamp, are used with success for the sterilization of water and even of milk. Their use in medicine (cyanotherapy) has not always been well interpreted, and this is why we are astonished to find that in lupus, eczema and erysipelas, Finsen and Rumpf prescribe the blue light, while Winternitz, Unna and Krukenberg prefer red light in the same cases. But the red and blue lights, despite their diverse properties, may readily produce similar therapeutic results. Here are two facts which prove this. A young girl, attacked by a purely tropo-neurotic eczema, found her affection slightly aggravated by the blue light, while she was rapidly cured by the red rays. On the contrary, a man of 55, suffering from chronic suppurating eczema, derived no benefit from the red rays, but later found his lesions rapidly ameliorated by the methodic application of blue light. The interpretation of these apparent contradictions is simple. In the first case the red light alone could be useful because penetrating and dynamogenic. In the second case only the blue light could give satisfactory results, since the state of the skin and the nervous system rendered the first less penetrable to the red rays and the second less sensitive to their action, ... and moreover the blue rays are especially active against that particular affection of the skin.

"Consequently, erythrotherapy and cyanotherapy are equally apt in certain cases to produce the amelioration of the same morbid condition, but the first maintains or augments the vital resistance and the natural defenses of the organism, while the second limits its action to the reduction of the activity and of the virulence of microbes.

"Both are equally used in psychotherapy. As far back as 1890 de Courmelles prescribed blue or violet light for certain dental troubles. I have also noted that the same color was soothing in intercostal neuralgia. Finally Finsen observed that the violet and ultra-violet rays relieved in some degree the pain of superficial cancers and cancers of the breast.

"From a purely psychotherapeutic point of view results seem still more valuable. In a red atmosphere depressed neurasthenics, and victims of alcohol, hypochondria, or melancholia, nearly always improve and recover the desire of activity and the need of movement.

Inversely, in a blue or violet atmosphere excited, delirious, or maniacal patients little by little regain tranquility. Dr. Farez utilized these properties to obtain with more facility hypnosis and therapeutic suggestion. Placed in a red chamber if they had need of stimulation, in a blue or violet if they needed calming, the patients responded better to the questions of the doctor, explained their condition more fully and thus profited the better by his advice."

The Synthesis of Ammonia from Its Elements—I*

The Commercial Exploitation of the Earth's Atmosphere

By H. A. Bernthsen

YOU all know that of the chemical elements that occur in large quantity on our planet, nitrogen is one which is characterized by its complete indifference to chemical attack. Berzelius already says of it: "It is difficult to recognize because it does not differ from other gases by any conspicuous property, but can only be recognized by means of properties which it does not possess." We see therefore both in science and in arts that nitrogen is frequently used when it is desired to protect bodies from chemical attack by oxygen or when the commencement of an oxidation is to be prevented. The vacuum of the thermometers in instruments which are intended for high temperatures is, as you are aware, filled with nitrogen. The storage of readily combustible liquids, such as coal tar benzene and light petroleum naphtha, is effected by covering these bodies with nitrogen; their transport by applying compressed nitrogen. It is to the indifference of this element to chemical attack that the curious state of affairs must be attributed, that although we are dependent for all the conditions of life on compounds of this body and although we live in an infinite ocean of nitrogen, yet up to a short time ago we were not in a position to obtain nitrogen compounds from it. We were forced to cover our requirements of

saltpeter for gunpowder, of nitric acid for gun-cotton and for nitration and many other applications, of ammonia for refrigerators, for instance, and so on, not by drawing upon the nitrogen of the air, but by utilizing ready formed nitrogen compounds, which ultimately result from the processes of plant life of earlier times. On the one hand Chili saltpeter and on the other hand the ammonia liquor obtained in small proportions as a by-product in the manufacture of gas or coke from coal served to supply the wants mentioned. We were also and in particular dependent on these two sources of nitrogen for the requirements of agriculture, which are far greater than all the other taken together.

But now, while the requirements of nitrogenous manures are constantly increasing, in order to guarantee to the inhabitants of the world sufficient harvests, we have in all probability to reckon with a comparatively rapid diminution of the supply of natural Chili saltpeter. On the other hand we cannot expect the balance to be maintained by a rapid increase in the production of ammonium sulphate, for this is dependent on the manufacture of gas and of coke, which increases but slowly. To this, some working up of peat may be added, but a production of ammonia in this way as the main object of manufacture is impossible. The problem of the conquest of elementary nitrogen, of forcing this obstinate scamp into

the service of our civilization, has consequently attained immediate importance for some time. Already three years ago at the Seventh International Congress of Applied Chemistry in London, I therefore had the honor of reporting on the utilization of atmospheric nitrogen and a new way for the production of nitrates from the air.

It might appear that the American continent, which is so richly blessed with the treasures of nature, can perhaps await with greater patience the development of events than could most European countries. For while the soil of the latter has been worked to the uttermost through centuries of agriculture, the unexampled development of this country has been caused, to a great extent by the fact that agriculture had virgin soil at its disposal wherever it developed. There may still be places, such as the English poet Browning sings of:

"Nature frames

Some happy lands, that have luxurious names,
For loose fertility; a footfall there
Suffices to upturn to the warm air
Half-germinating spices; mere decay
Produces richer life; and day by day
New pollen on the lily petal grows,
And still more labyrinthine buds the rose."

In general, however, a change is occurring. The soil

* Paper read before the Eighth International Congress of Applied Chemistry.

of the Eastern States, if it is to yield full harvests in the future, already requires the addition of manures, above all of the nitrogenous manures, for lack of the latter is most quickly noticed by the plants. A similar treatment would further be of great advantage in many parts of the Southern cotton States. Finally, in the course of years, the same requirements will be noticed in the West more and more, as the development of hitherto uncultivated land even there now hardly comes into consideration. Nature will only continue to shower her favors on man if he adapts himself with reason to her immutable laws, as expressed by the poet:

"Nur der verdient sich Freiheit wie das Leben,
Der täglich sie erobern muss."¹

I therefore count upon your interest if I deal to-day in some detail with the nitrogen question, and announce to you some of the progress that has been made since the last Congress.

The three methods employed for the fixation of nitrogen are: First, the direct oxidation of nitrogen of the air forming nitric acid, nitrates, etc.; second, the synthesis of ammonia from nitrogen and hydrogen; and third, the fixation of nitrogen to metals or metalloids and, if desired; subsequently decomposing the resulting products, nitrides, etc., producing ammonia. Three years ago it was the first of these ways with which I dealt principally. I was in a position to announce that in the processes of Birkeland of Christiania, on the one hand, and of Schönherr and the Badische Anilin- & Soda-Fabrik, on the other hand, two important ways had been opened up for oxidizing the atmospheric nitrogen with the aid of electricity obtained from water power. Two companies had been formed by a Norwegian-French group, the Norsk Hydro Elektrisk Kvaestofaktieselskab, and a German group, the Badische Anilin- & Soda-Fabrik together with the Farbenfabriken of Elberfeld and the Actiengesellschaft für Anilinfabrikation of Berlin. These undertakings and some other associated enterprises have in the meantime been developed with great energy and the factory at Saaheim, which converts about 120,000 horse-power of the Rjukan fall into oxides of nitrogen, is now in full swing. The management of these works has passed into the hands of the Norwegian-French group by an arrangement with the German group.

The process for the combination of nitrogen with metals, etc., producing metallic nitrides, cyanamids, and the like, and from these ammonia, have also progressed.

On the one hand the nitrolime obtained for instance by the union of nitrogen with calcium carbide, which is produced in several factories, is in part utilized directly as manure; in part a beginning has been made with the manufacture of ammonia from it by treatment with steam. On the other hand the nitrides, and especially those of aluminium and silicon, have been more closely studied. The process of Serpek for the production of aluminium nitride has been developed by the Société Générale des Nitrures on a manufacturing scale in order to obtain on the one hand, pure alumina for the production of aluminium, and on the other, ammonia. Then again the Badische Anilin- & Soda-Fabrik in following up its work on barium cyanide from nitrogen, barytes and carbon took up the study of the production of titanium-nitrogen compounds and that of silicon nitride from silica, nitrogen and carbon, and then in connection with this the production of mixed nitrides of silicon and aluminium, and of aluminium nitride itself. In this field of work also an arrangement has been made between the firms working it, the Badische Anilin- & Soda-Fabrik having assigned their patents to the Société Générale, retaining for themselves certain rights of preparing the nitrides in question according to the patents of both companies. It is to be expected that this branch of industry will also develop satisfactorily.

I refrain from discussing any of these methods of fixing nitrogen and refer to the communications made by the inventors themselves and in particular to the lecture delivered a few days ago at this Congress, by Dr. Eyde,² the general director of the Norwegian companies referred to.

I propose to deal to-day however, from my own direct experience, with the development of the problem for the synthetical manufacture of ammonia from its elements. A few years ago the solution of this problem appeared to be absolutely impossible. It has recently been the object of very painstaking investigations by Prof. Haber and the chemists of the Badische Anilin- & Soda-Fabrik, and numerous patents have been taken out with reference to the manufacture. Apart from what is already published in this way, however, we have refrained from any other announcements until we were in a position to report something final with reference to the solution of the technical question.

This moment has now arrived and I am in the agreeable position of being able to inform you that the said problem has now been solved fully on a manufacturing scale, and that the walls of our first factory for synthetic ammonia are already rising above the ground at Oppau, near Ludwigshafen-on-Rhine; this factory will be opened by the middle of next year.

Permit me therefore to explain to you the fundamental points upon which this latest achievement of chemical industry is based.

The affinity of nitrogen for hydrogen, as is well known, is so small that the two do not appreciably unite with one another either at ordinary or at a raised temperature. It has long been known that by electric sparks or by a silent discharge very minute quantities of ammonia can be formed from nitrogen and hydrogen. Also by conducting a mixture of hydrogen with nitrogen prepared in a particular way over spongy platinum, Johnson (1881) thought that he had obtained ammonia, in a quantity amounting to 0.0059 gramme of NH_3 per hour. The nitrogen had been obtained from ammonium nitrite and passed through ferrous sulphate solution in order to remove nitric oxides. But nitrogen prepared in other ways did not yield the ammonia, so that Johnson assumed that there were two modifications of nitrogen. Wright (1881) proved that ferrous sulphate did not absorb all the nitrogen oxides and that the ammonia was produced by the action of hydrogen on nitrogen oxide in the presence of platinum. When using pure nitrogen he also obtained no ammonia. Baker (1883) also came to the conclusion that Johnson's statements as to the production of ammonia from its elements were mistaken. In no case could Baker notice any signs of the formation of ammonia, and he decided that hydrogen does not combine with nitrogen under the influence of heated platinum sponge.

Ramsay and Young on the other hand (1884) determined the decomposition of ammonia by heat at various temperatures. In this research, among other experiments, a mixture of dry nitrogen and hydrogen was passed through a red-hot glass tube filled with iron filings, or through an iron tube. The presence of ammonia could again not be proved. When using moist gases they noticed the presence of traces of ammonia, the formation of which they explained by the decomposition of water and the production of nascent hydrogen.

Again, Perman, twenty years later, occupied himself with the question of the formation of ammonia from its elements. Upon slowly passing a mixture of nitrogen and hydrogen (1 vol.: 3 vol.) through a glass tube heated to red heat, he obtained no ammonia, and the same result was attained when the tube was filled with porcelain. But when the mixture, in a moist condition, was passed over red-hot iron or several other metals, or over asbestos, pumice, pipe-clay, etc.,³ traces of ammonia were formed, according to Perman's statement.

The investigations entered upon a new phase when Haber, armed with the weapons of modern physical-chemical methods, attacked the problem of the estimation of the ammonia equilibrium in 1904 in conjunction with van Oordt.⁴ These investigators showed that at a temperature of about 1,000 deg. Cent. decomposition

¹ "He only earns his liberty, as his living, who day by day must win it by the dint of battle."

² See SCIENTIFIC AMERICAN SUPPLEMENT, No. 1925.

of ammonia into its elements was almost, but not quite, quantitative (of 1,000 molecules of ammonia 999.76 were decomposed at a temperature of 1,020 deg. Cent.), and that consequently from these elements and under the same conditions very small quantities of ammonia were formed. The authors used as contact material, iron prepared from iron oxalate by heating to red heat in a current of hydrogen, and the iron was spread out upon purified asbestos. Further, for some experiments nickel was precipitated from nickel nitrate upon pure silica. From a mixture of nitrogen and hydrogen corresponding to 100 parts of ammonia they obtained at the temperature mentioned about 0.02 parts of ammonia, and even this figure was subsequently, by more accurate examination (see below), shown to be still too high. In a further publication in 1905,⁵ these results were confirmed and summarized in the following statement: at the temperature of commencing red heat and upward, no catalyzer is capable of producing more than traces of ammonia. The work was carried out at ordinary atmospheric pressure "for practical reasons," and it was pointed out that even under considerable increased pressure the position of the equilibrium would remain very unfavorable. Manganese was also taken into consideration as a catalyzer, but its effect, as also that of nickel, was less satisfactory than that of iron.

While Haber in company with Le Rossignol⁶ pursued this line of research, Nernst communicated the results of similar investigations to the general meeting of the German Bunsen Gesellschaft at Hamburg in 1907.⁷ He was induced to take the matter up by the fact that Haber's figures showed a remarkable discrepancy from the equilibrium figures calculated according to the famous "heat theorem" of Nernst himself. In order to determine the otherwise so minute quantities of ammonia, Nernst worked under pressure, using as a rule about 50 and up to 75 atmospheres, for according to the well-known laws the concentration of the ammonia increases with the pressure. These results were published more in detail a year later by his co-worker, Jost.⁸ The latter used as catalysts besides platinum foil or iron (prepared from iron oxide in a current of hydrogen) also manganese (obtained from an electrically prepared amalgam by driving off the mercury in a current of ammonia). The figures here obtained for the equilibrium were still lower than Haber's, a fact which Nernst said was very regrettable, for otherwise one might really have thought of preparing ammonia synthetically from hydrogen and nitrogen. Haber and Le Rossignol made a further publication in 1908,⁹ having now made their measurements also at a pressure of 30 atmospheres. By this means, it is true, the differences as against Nernst's experiments on account of the position of equilibrium, as also the maximum percentage of ammonia obtainable at a given temperature, were not quite got over, but at all events the figures of both scientists agreed in showing that this maximum is extremely low. At a temperature of 1,000 deg. Cent. the volume percentage of ammonia calculated for atmospheric pressure is 0.0048 per cent according to Haber and 0.0032 per cent according to Jost, the corresponding figures at 700 deg. Cent. being 0.0221 per cent and 0.0174 per cent.¹⁰ That is, at these temperatures the ammonia equilibrium is extremely unfavorable, while at lower temperatures the catalytic action of the metals in question was too low to be able to work with them.

To be continued.

³ The action of these latter bodies was explained by the presence of iron in them, but it may be stated that the alleged action of asbestos, pipe-clay and pumice is due to a mistake.

⁴ *Z. anorg. Chem.*, 43, 111.

⁵ *Ibid.*, 44, 341.

⁶ *Ber.*, 40, II, 2,144 (1907).

⁷ *Zeit. für Elektrochemie*, 13, 521 (1907).

⁸ *Z. anorg. Chem.*, 57, 414.

⁹ *Zeit. für Elektrochemie*, 14, 181 (1908).

¹⁰ *Z. anorg. Chem.*, 57, 193; *Zeit. für Elektrochemie*, 14, 193.

Artificial Silks

ARTIFICIAL silk is fast coming to be a very important textile material and is being used in ever-increasing quantities by the trade. It is employed as an adjunct not only to the silk industry itself, but is also being used in connection with wool and cotton in the preparation of a great variety of fabrics. It is even being used largely in knit goods and hosiery in combination with cotton and mercerized cotton.

The dyer, therefore, is meeting more and more with this product, and as there are three different kinds of artificial silks in general use, and as these different varieties possess certain differences in structure and quality, it really becomes a question of considerable importance to the dyer to know one variety from another.

This is more especially important because one silk may stand a treatment which would be fatal to another.

The three artificial silks now to be met with on the market are described in a recent issue of the *Wool and Cotton Reporter* as follows:

1. Collodion silk, known also as Chardonnet, or nitrosilk. It is prepared from nitrated cotton.
2. Cuprate silk, known also as Glanzstoff, Pauly, Elberfeld silk. It is prepared from a solution of cellulose in cuprammonium solution.
3. Viscose silk. This is prepared from a solution of cellulose in a mixture of caustic soda and carbon disulphide.

In their outward appearance the three forms of artificial silk are so nearly alike that it would not be

possible to distinguish between them. Even a microscopic examination by an experienced observer does not lead to any positive conclusion as to kind of silk.

A fairly simple test, however, and one which may be easily carried out by the average dyer, is the following: A sample of the silk to be tested is placed in a small porcelain dish, and concentrated sulphuric acid is poured over the fibers. If the sample consists of collodion silk no coloration appears until about an hour has elapsed, when the acid solution will acquire a pale yellow color.

In the case of cuprate silk the acid becomes yellow immediately and the color becomes deeper on standing. In the case of viscose silk the acid immediately develops a reddish brown color, deepening to a rusty brown after standing for an hour.